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Innovation of Synbiotic Yogurt Product Based on Red Dragon Fruit (*Hylocereus polyrhizus*) with Added Inulin as an Effort to Improve Digestive Health

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Abstract: Digestive health is closely associated with the balance of the gut microbiota, and synbiotic foods that combine probiotics and prebiotics may support beneficial microbial activity and overall gastrointestinal health. This study aimed to develop a synbiotic yogurt formulated with red dragon fruit (*Hylocereus polyrhizus*) and inulin extracted from kepok banana (*Musa paradisiaca*) and to evaluate its physical, chemical, and organoleptic characteristics. A descriptive experimental design was used, with yoghurt fermented with *Lactobacillus bulgaricus* and *Streptococcus thermophilus* and formulated with varying concentrations of red dragon fruit extract and banana-derived inulin (P0–P4). The evaluated variables included pH and sensory attributes consisting of color, aroma, taste, texture, and overall acceptability, assessed by 10 untrained panelists using a 1–5 hedonic scale. Data were analyzed descriptively and quantitatively to compare responses across formulations. The results showed that higher concentrations of red dragon fruit extract produced more intense red colouration, while higher inulin levels were associated with a thicker, smoother yoghurt texture and a slight decrease in pH, indicating increased fermentation activity. Sensory evaluation showed favorable acceptance, with dominant scores of 4.5 for color, taste, and overall acceptability, 4.0 for texture, and 3.5 for aroma. The combination of red dragon fruit and kepok banana-derived inulin therefore improved the sensory and functional characteristics of yogurt and demonstrated potential as a synbiotic functional food that may support digestive health.

Keywords: Banana; Biotechnology; Fermentation; Synbiotic; Yoghurt.

Introduction

Digestive health is closely associated with the composition and activity of the gut microbiota, which contributes to nutrient metabolism, intestinal homeostasis, and interactions with the host immune system. Disruption of the gut microbial ecosystem may be associated with various gastrointestinal and metabolic conditions. Dietary strategies involving fermented foods, probiotics, prebiotics, and synbiotics have therefore received increasing attention as approaches for supporting gastrointestinal health [1], [2]. Yoghurt is one of the most widely consumed fermented dairy products and is traditionally produced by lactic acid bacteria, particularly *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*. Beyond its nutritional value, yogurt can serve as a carrier for probiotic microorganisms and functional food ingredients [3], [4].

Synbiotics have become an important concept in functional food development because they combine live microorganisms with substrates that are selectively utilized by host microorganisms and provide a health benefit [5]. The current consensus definition distinguishes complementary and synergistic synbiotics, emphasizing that evidence of the intended health benefit and appropriate utilization of the substrate is important when a product is described as synbiotic [5]. In food applications, synbiotic formulations commonly incorporate prebiotic dietary fibers such as inulin into fermented dairy products. Inulin is a fructan-type soluble dietary fiber that is poorly digested in the upper gastrointestinal tract and can be fermented by microorganisms in the large intestine. Its incorporation into yogurt has also been investigated for technological functions, including modification of viscosity, firmness, consistency, syneresis, and sensory characteristics [6]–[8]. For example, inulin supplementation has been reported to improve the technological and sensory characteristics of synbiotic yogurt products, while its effects may vary according to concentration and the microbial culture used [7], [8].

The use of locally available plant materials as sources of functional ingredients provides an opportunity to develop value-added fermented foods. Banana is an important tropical crop and contains dietary fiber and resistant starch, while some banana-derived materials have been investigated as potential sources of prebiotic ingredients. In Indonesia, kepok banana (*Musa* spp.) is widely available and has potential for utilization in food processing. Previous research on banana-derived inulin has demonstrated its application in synbiotic yogurt formulations, including the evaluation of sensory characteristics of yogurt supplemented with banana-derived inulin [9]. This finding suggests that banana-based ingredients may provide both functional and technological opportunities in fermented dairy products. However, the composition of a crude or partially processed banana-derived extract may contain other components in addition to inulin; therefore, its technological effects should be interpreted as the contribution of the whole ingredient unless the actual inulin concentration has been analytically determined.

Red dragon fruit (*Hylocereus polyrhizus*) is another locally available tropical fruit with potential for functional

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food development. The red-fleshed fruit contains dietary fiber, phenolic compounds, and betalain pigments, including betacyanins, which contribute to its characteristic red-purple color and antioxidant potential [10]–[12]. Recent reviews and compositional studies have identified red dragon fruit as a promising source of bioactive compounds, particularly betalains and phenolic constituents [10], [11]. The presence of these compounds makes red dragon fruit attractive as a natural ingredient for improving both the nutritional and visual characteristics of food products. In fermented dairy products, the incorporation of red dragon fruit juice has been reported to influence physicochemical and sensory characteristics of yogurt, including pH, aroma, color, and taste [13]. These findings indicate that red dragon fruit can function not only as a source of bioactive compounds but also as a natural color and flavoring ingredient in yogurt.

Recent studies have examined the incorporation of red dragon fruit or its by-products into yogurt. Siregar *et al.* reported that the addition of red dragon fruit juice affected the physicochemical and sensory characteristics of yogurt, with a 10% juice formulation identified as the best formulation within their experimental conditions [13]. Similarly, the incorporation of red dragon fruit peel powder has been investigated for its effects on comprehensive quality attributes and sensory properties of yogurt [14]. These studies demonstrate the potential of red dragon fruit as a functional ingredient in fermented dairy products. However, they primarily focus on the effects of the fruit or its by-products as a single functional ingredient, rather than on their combination with a locally derived prebiotic ingredient.

In parallel, several studies have investigated inulin-containing synbiotic yogurt. Inulin supplementation has been associated with changes in yogurt texture, viscosity, water-holding capacity, syneresis, sensory properties, and, in some formulations, the viability of probiotic or starter cultures [6]–[8]. Jaman *et al.* evaluated synbiotic yogurt containing different prebiotics and reported that prebiotic incorporation affected sensory properties, water-holding capacity, syneresis, and viscosity [8]. Other studies have demonstrated that inulin can improve the technological and sensory properties of synbiotic yogurt and may support the viability of selected probiotic microorganisms during storage [6], [7]. Nevertheless, these studies generally used purified or commercially prepared inulin rather than an inulin-rich ingredient derived specifically from kepok banana.

Based on these findings, an important research gap remains in the integration of red dragon fruit extract and kepok banana-derived inulin within the same yogurt formulation. Although previous research has separately demonstrated the potential of red dragon fruit in yogurt and banana-derived inulin in synbiotic formulations, limited information is available regarding their combined effects on the physicochemical and sensory characteristics of yogurt. The combination is of particular interest because the two plant-derived ingredients may provide complementary technological functions: red dragon fruit contributes natural pigmentation and fruit-derived bioactive compounds, whereas the banana-derived ingredient may contribute soluble fiber and textural properties. However, whether these ingredients can be combined while maintaining favorable sensory characteristics requires experimental evaluation.

Therefore, this study aimed to develop a synbiotic yogurt formulated with red dragon fruit (*Hylocereus polyrhizus*) and an inulin-rich extract derived from kepok banana. The study specifically evaluated the pH and sensory characteristics of the resulting formulations, including color, aroma, taste, texture, and overall acceptability. The study used a descriptive experimental approach to compare formulation-related trends and to explore the potential of combining locally available plant resources for the development of a yogurt-based functional food. The findings are expected to contribute to the development of locally sourced functional food formulations and provide a practical example of applying food biotechnology principles to fermented food innovation.

Research Methods

Research Design

This study employed a descriptive experimental design to develop and characterize synbiotic yogurt formulated with red dragon fruit (*Hylocereus polyrhizus*) and kepok banana (*Musa paradisiaca*)-derived inulin. The design was selected because the primary objective was to observe and describe changes in the physical, chemical, and sensory characteristics of yogurt resulting from different formulation treatments rather than to establish causal effects through inferential statistical testing. The treatment formulations consisted of different combinations of red dragon fruit juice and banana-derived inulin, designated as P0–P4. The independent variables were the formulation levels of red dragon fruit and banana-derived inulin, while the observed dependent variables were pH and sensory characteristics, including color, aroma, taste, texture, and overall acceptability.

The study was conducted from October to November 2025 in East Jakarta. The experimental procedures used sterilized household equipment to maintain hygiene during preparation and fermentation. The principal ingredients consisted of full-cream milk, commercial yogurt starter cultures containing *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, ripe red dragon fruit, semi-ripe kepok banana as the source of inulin-rich extract, granulated sugar, and distilled water.

Preparation of Banana-Derived Inulin Extract

Kepok bananas were selected at the semi-ripe stage and processed to obtain an inulin-rich extract. The bananas were first sliced and steamed until softened. The softened slices were then blended into a puree and filtered to obtain the banana extract. The resulting extract was subsequently incorporated into the yogurt formulations according to the predetermined treatment levels. The use of banana extract was intended to provide a locally sourced prebiotic component in the synbiotic yogurt formulation.

Preparation of Red Dragon Fruit Juice

Ripe red dragon fruit was washed, peeled, and processed by blending the fruit flesh. The blended material was filtered to obtain a smooth red dragon fruit juice. The juice was subsequently added to the yogurt according to the

designated treatment formulation. The red coloration of the juice provided a natural visual characteristic associated with the presence of betalain pigments.

Yogurt Preparation and Treatment Formulation

The basic yogurt was prepared by heating full-cream milk to 85°C and subsequently cooling it to approximately 43°C. The yogurt starter containing *L. bulgaricus* and *S. thermophilus* was then added. The mixture was fermented for 6–8 h at room temperature. Following fermentation, the yogurt was combined with different concentrations of banana-derived inulin extract and red dragon fruit juice according to the P0–P4 treatment groups. The formulated yogurt samples were refrigerated for approximately 12 h to allow flavor and texture maturation before evaluation.

pH Measurement

The pH of each yogurt formulation was measured after the formulation and maturation process to characterize the acidity of the fermented products. The pH values were used descriptively to identify the direction of change in acidity among formulations with different levels of red dragon fruit and banana-derived inulin. A lower pH was interpreted as indicating greater acidification associated with fermentation activity; however, because the present study used descriptive analysis, differences in pH were not interpreted as statistically significant.

Sensory Evaluation and Panelist Sampling

Sensory evaluation was conducted using a non-probability convenience sampling technique involving 10 untrained panelists. Panelists were selected based on their availability and willingness to participate in the sensory evaluation. The panelists evaluated five sensory attributes: color, aroma, taste, texture, and overall acceptability. Each attribute was assessed using a 5-point hedonic scale, ranging from 1 (strongly dislike) to 5 (strongly like).

The use of untrained panelists was intended to obtain a preliminary indication of consumer-oriented acceptance rather than expert sensory profiling. Consequently, the sensory data represent the subjective preferences of a small group of available panelists and should not be interpreted as representative of the broader consumer population. Differences in individual sensory perception may also contribute to variability in the responses. These limitations were considered when interpreting the sensory results.

Data Analysis

The collected data were analyzed using descriptive quantitative analysis. For pH measurements, the observed values were descriptively compared across the P0–P4 formulations to identify patterns in formulation-associated acidity. Sensory responses were summarized according to the distribution of hedonic scores for each attribute, and the dominant score was identified as the most frequently selected rating among the panelists. The sensory results were then compared across attributes to describe the overall acceptance pattern of the formulated yogurt.

Descriptive analysis was selected because the study was designed as an initial formulation and product-characterization study with a relatively small number of untrained panelists. Therefore, the analysis emphasized the distribution and tendency of observed responses rather than population-level statistical inference. No inferential statistical test was applied, and the findings are interpreted as descriptive evidence of formulation characteristics and preliminary sensory acceptance. Future studies should involve a larger and more systematically selected panel, repeated experimental observations, and appropriate inferential statistical tests to confirm whether differences among formulations are statistically significant.

Results and Discussion

Physical and Chemical Characteristics

The synbiotic yogurt formulations showed observable differences in physical characteristics according to the concentration of red dragon fruit extract and kepok banana-derived inulin-rich extract. Formulations containing higher levels of red dragon fruit, particularly P3 and P4, exhibited a more intense red coloration. This observation is consistent with the presence of betalain pigments in red-fleshed dragon fruit, particularly betacyanins, which contribute to its characteristic red to purple coloration [15], [16]. The concentration of betalain pigments may vary according to cultivar, maturity, and processing conditions. Angonese et al. reported that *Hylocereus polyrhizus* contains appreciable amounts of betalains and other bioactive compounds, supporting its potential as a natural colorant and source of bioactive compounds in food products [15]. A recent review also emphasized that red dragon fruit is particularly rich in betacyanins, although their stability can be affected by processing and environmental conditions [16].

The increased color intensity observed in the present study is also consistent with previous research on dragon-fruit-enriched yogurt. Siregar et al. reported that the addition of red dragon fruit juice affected the sensory characteristics of yogurt, including color, aroma, and taste [17]. Similarly, Yeasmin et al. found that fortification of yogurt with red dragon fruit peel powder altered several physicochemical characteristics and improved antioxidant-related properties, while the sensory response varied according to the level of fortification [18]. Research on yogurt ice cream containing red dragon fruit puree also demonstrated that increasing the proportion of dragon fruit influenced color and other sensory characteristics [19]. Therefore, the more intense red coloration observed in P3 and P4 can reasonably be attributed to the greater contribution of red dragon fruit pigments.

The addition of kepok banana-derived inulin-rich extract was associated with an increase in yogurt thickness and a smoother consistency. Inulin is a soluble dietary fiber with technological properties that can influence the structure and mouthfeel of food products. Its physicochemical characteristics allow it to interact with water and other food components, potentially contributing to viscosity, firmness, and consistency [20], [21]. In yogurt systems, the incorporation of prebiotics has been reported to influence water-holding capacity, syneresis, viscosity, and textural properties [22]. Jaman et al. found that the addition of

prebiotic ingredients, including inulin, affected the sensory properties, water-holding capacity, syneresis, and viscosity of synbiotic yogurt [22].

The present observation is also consistent with the findings of Iriondo-DeHond et al., who reported that inulin supplementation increased the firmness and consistency of yogurt [23]. Similarly, El-Kholy et al. demonstrated that extracted inulin could modify the physicochemical, textural, microstructural, and sensory properties of low-fat synbiotic yogurt [24]. These findings support the possibility that the thicker consistency observed in the present study was partly related to the water-binding and structural contribution of the banana-derived ingredient.

However, the banana-derived material used in the present study was an inulin-rich extract rather than analytically purified inulin. Therefore, the observed textural effect should not be attributed exclusively to inulin. Other soluble solids, dietary fiber, starch-derived components, or other constituents of the banana extract may also contribute to the observed consistency. This distinction is important because the actual concentration and purity of inulin in the extract were not quantified in the present study.

The pH values of all formulations were within the acidic range, while formulations containing higher levels of the banana-derived ingredient tended to have lower pH. Yogurt acidification is primarily associated with the conversion of lactose and other fermentable substrates into organic acids by lactic acid bacteria. The acidification process contributes to the characteristic sour taste and gel formation of yogurt [25]. However, the effect of added prebiotics on yogurt pH is not necessarily uniform. Jaman et al. reported that several prebiotic treatments did not significantly affect yogurt pH or titratable acidity, despite influencing other physicochemical characteristics [22]. Delgado-Fernández et al. likewise demonstrated that the type and concentration of prebiotic carbohydrate could influence the acidification behavior and physical properties of synbiotic yogurt [26]. Therefore, the lower pH tendency observed in the present study may reflect differences in formulation composition and fermentation behavior, but it should not be interpreted as direct evidence that the banana-derived inulin increased lactic acid bacterial activity.

The present study used descriptive quantitative analysis; consequently, the observed differences among formulations represent formulation-related trends rather than statistically confirmed treatment effects. Further experiments involving replicated pH measurements, titratable acidity, viable lactic acid bacterial counts, and fermentation kinetics are required to establish the relationship between the banana-derived ingredient and yogurt acidification (Table 1).

Organoleptic Characteristics

The sensory evaluation demonstrated generally favorable acceptance of the synbiotic yogurt formulations. The dominant sensory values were 4.5 for color, taste, and overall acceptability, followed by 4.0 for texture and 3.5 for aroma (Table 1). These values indicate that the product was generally perceived positively by the participating panelists, although the lower aroma score suggests that aroma may require further formulation optimization. The sensory results should be interpreted as descriptive observations because only 10 untrained panelists participated in the evaluation.

The relatively high color score is consistent with the intense red coloration generated by red dragon fruit. Color is an important determinant of consumer perception because it provides an initial visual expectation of fruit content and product flavor. Siregar et al. found that red dragon fruit juice influenced the color and other sensory properties of yogurt [17]. Yeasmin et al. also reported that red dragon fruit peel powder altered the color and overall sensory characteristics of yogurt, although excessive incorporation could affect consumer acceptance [18]. The present findings therefore support the use of red dragon fruit as a natural ingredient for improving the visual characteristics of yogurt.

Taste received a dominant score of 4.5, indicating favorable acceptance among the panelists. This result may be associated with the combination of the sweet-acidic characteristics of red dragon fruit and the characteristic acidity of fermented milk. Siregar et al. reported that red dragon fruit juice affected the taste and aroma of yogurt [17]. Similarly, the incorporation of red dragon fruit into yogurt-based products has been shown to influence consumer perception of flavor and taste [19]. However, the present panelists suggested increasing sweetness and reducing sourness. This feedback indicates that the overall taste was acceptable but that the balance between fruit sweetness and yogurt acidity could still be improved.

Texture obtained a dominant score of 4.0 and was associated with a thicker, smoother consistency observed after incorporating the banana-derived ingredient. The technological role of inulin in modifying yogurt texture has been reported in several studies. Inulin-containing yogurt has been associated with changes in firmness, consistency, viscosity, and mouthfeel [20], [23], [24]. Jaman et al. also observed that prebiotic supplementation influenced yogurt body and texture, although the magnitude of the effect depended on the type and concentration of the prebiotic [22]. Thus, the relatively favorable texture score in the present study may be related to the contribution of the banana-derived extract to the yogurt matrix.

Nevertheless, some panelists suggested that the product should be made creamier and less watery. This observation is relevant because sensory acceptance is influenced not only by increased thickness but also by the balance between viscosity, creaminess, and perceived smoothness. Inulin does not always produce the same rheological response in all yogurt systems. Delgado-Fernández et al. demonstrated that the physical response of synbiotic yoghurt depended on the type of carbohydrate and the formulation's acidification behaviour [26]. Therefore, future optimization should determine the concentration of banana-derived extract that provides adequate thickness without producing an undesirable watery or excessively dense mouthfeel.

Aroma received the lowest dominant score of 3.5. Although this score remained within an acceptable range, the result suggests that aroma was less favorable than color and taste. The characteristic aroma of fermented milk may interact with the aroma compounds contributed by red dragon fruit. Previous studies have shown that fruit addition can modify the aroma profile and sensory perception of yogurt products [17], [19]. In the present study, panelists specifically recommended strengthening the fruit aroma.

This recommendation suggests that the aroma contribution of red dragon fruit may not have been sufficiently pronounced under the formulation conditions used.

Table 1. Organoleptic Evaluation Summary

Evaluated Aspect	Dominant Score	Description of Evaluation Pattern
Color	4–5 (Like–Strongly Like)	Almost all panelists gave high scores; the color was considered attractive and appropriate for dragon fruit products.
Aroma	3–4 (Neutral–Like)	Several panelists gave neutral scores, indicating that the aroma was not too strong but still acceptable to most panelists.
Taste	4–5 (Like–Strongly Like)	Taste became the strongest aspect; the majority of panelists liked the balance of acidity and sweetness in the product.
Texture	4 (Like)	The texture was rated as good, soft, and similar to typical yogurt; no negative evaluations were reported.
Overall Acceptability	4–5 (Like–Strongly Like)	The product was generally well accepted by the panelists.

Note: The dominant scores represent the most frequently chosen ratings given by the panelists for each sensory attribute. These scores reflect the overall tendency of panelist preferences, showing which aspects were most liked or neutrally received. Higher dominant scores (4–5) indicate strong acceptance and positive perception, while mid-range scores (3–4) suggest moderate acceptance with room for improvement.

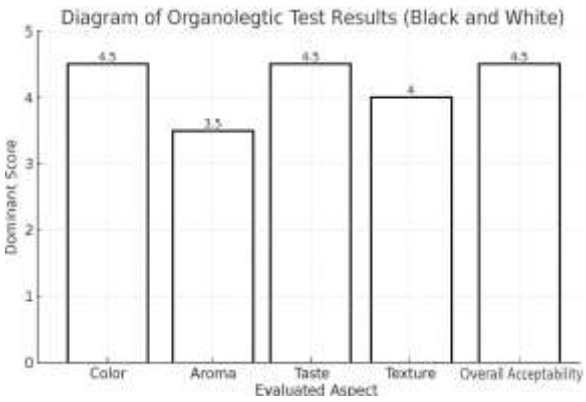


Figure 1. Organoleptic Evaluation Summary

Note: The diagram of the organoleptic test results for dragon fruit yogurt products shows that the attributes of color, taste, and acceptability have the highest dominant value (4.5), followed by texture (4), while aroma obtained the lowest value, namely 3.5.

Based on Figure 1, the dominant sensory scores for the synbiotic yogurt fall within the 4–5 range, indicating that panelists generally rated the product from 'like' to 'very like.' Taste and texture were the most highly appreciated attributes, each reaching a dominant score of 4.5, while aroma, although slightly lower at 3.5, remained within an acceptable category. These results align with the previous sensory assessment table, reinforcing that the yogurt's color, taste, texture, and overall acceptability were positively received by the panelists. The bar chart further emphasises that all evaluated attributes fall within a favourable acceptance range, confirming that the product met key sensory expectations.

Alongside these numerical evaluations, panelists provided constructive feedback aimed at enhancing the product further. Suggestions primarily focused on adjusting flavor balance by increasing sweetness, reducing sourness, and strengthening the fruit aroma to make it more appealing. Improvements in texture were also recommended, particularly making it creamier and less watery, as well as ensuring better harmony among the dragon fruit, yogurt, and inulin components. Several panelists highlighted packaging improvements, recommending more attractive, practical, and eco-friendly containers. Overall, while the yogurt was well liked, these suggestions indicate clear opportunities to refine taste, aroma, texture, and presentation to further enhance consumer appeal and product quality.

Comparative Interpretation of the Formulations

The overall results indicate that red dragon fruit and the banana-derived ingredient contributed distinct yet potentially complementary characteristics to the yoghurt formulation. Red dragon fruit primarily contributed to color and fruit-related sensory characteristics, whereas the banana-derived ingredient was associated with increased thickness and smoother texture. The observed pH tendency suggests that formulation composition may also influence acidification, although this relationship requires further experimental verification.

The effect of red dragon fruit observed in this study is consistent with previous studies. Siregar et al. reported that red dragon fruit juice significantly affected pH and several sensory attributes of yogurt, particularly aroma, color, and taste [17]. Yeasmin et al. similarly observed changes in pH, acidity, antioxidant activity, and sensory characteristics when red dragon fruit peel powder was incorporated into yogurt [18]. These studies provide a relevant comparison because both evaluated dragon-fruit-derived ingredients in fermented dairy matrices.

The present findings also correspond with research on red dragon fruit in other yogurt-based products. Susanti et al. demonstrated that red dragon fruit puree affected the sensory and physicochemical characteristics of yogurt ice cream, including color and taste [19]. In another study, red dragon fruit puree was incorporated into coconut yogurt, and the resulting product was evaluated based on physical, chemical, and sensory properties [27]. These findings collectively indicate that red dragon fruit can modify the sensory identity of fermented dairy or yogurt-like products, particularly through its characteristic pigmentation and fruit flavor.

With regard to the prebiotic component, previous research has shown that inulin can modify the technological properties of yogurt. Sarwar et al. reported that inulin supplementation affected the textural and sensory properties of synbiotic yogurt and reduced syneresis at selected concentrations [28]. Kamel et al. further demonstrated that inulin supplementation could influence the viability of

Bifidobacterium bifidum and maintain acceptable sensory characteristics during storage [29]. More recently, Rahman et al. demonstrated that increasing inulin concentration in synbiotic yogurt containing locally isolated lactic acid bacteria was associated with increased bacterial viability, acidity, and water-holding capacity and reduced syneresis [30]. These findings reinforce the potential technological role of inulin in fermented dairy products.

However, the present study differs from these studies in that the prebiotic ingredient was obtained from a locally available banana source and was incorporated alongside red dragon fruit. Amelia et al. previously investigated synbiotic yogurt containing banana-derived inulin and demonstrated that banana-based ingredients could be used in synbiotic yogurt formulations [9]. The present study extends this concept by combining a banana-derived, inulin-rich ingredient with red dragon fruit in a single formulation. The combination provides a locally sourced approach to developing a yogurt product in which the fruit component contributes visual and sensory characteristics while the banana-derived component contributes functional dietary fiber and textural properties.

Despite these promising observations, the current data do not demonstrate a synergistic biological interaction between probiotics and the banana-derived ingredient. According to the current scientific definition of synbiotics, evidence of selective substrate utilization and a health benefit is important for establishing a product as a synbiotic [31]. Therefore, the present formulation should be regarded as a preliminary synbiotic yogurt formulation based on its intended combination of fermented microorganisms and a potential prebiotic ingredient. Further microbiological and functional studies are necessary to confirm the prebiotic effect and health-related functionality.

Conclusion

This study demonstrated that the formulation of synbiotic yogurt enriched with red dragon fruit (*Hylocereus polyrhizus*) and kepok banana (*Musa paradisiaca*)-derived inulin produced favorable functional, physicochemical, and sensory characteristics. Higher concentrations of red dragon fruit extract resulted in more intense red coloration, while the addition of banana-derived inulin contributed to a thicker and smoother yogurt texture and was associated with a slight decrease in pH, indicating greater acidification during fermentation. Sensory evaluation by 10 untrained panelists showed favorable acceptance, with dominant scores of 4.5 for color, taste, and overall acceptability, 4.0 for texture, and 3.5 for aroma. These findings indicate that the combination of red dragon fruit and banana-derived inulin can provide complementary functional and sensory characteristics in a yogurt-based synbiotic product. From a functional food development perspective, the use of locally available red dragon fruit and kepok banana-derived inulin provides an opportunity to develop value-added synbiotic yogurt based on Indonesian food resources. The formulation may serve as a preliminary model for further development of functional fermented foods at small-scale or household-industry level, particularly after optimization of sweetness, sourness, aroma, texture, and packaging as suggested by the panelists. From a food biotechnology learning perspective, this study also provides a practical example of integrating microbial fermentation, prebiotic ingredients, local agricultural resources, physicochemical evaluation, and sensory assessment into a functional food development process. Thus, the study can support contextual learning in food biotechnology by demonstrating how microbiological and biotechnological principles can be applied to product formulation and evaluation. Nevertheless, the findings should be considered preliminary because the sensory evaluation involved only 10 untrained panelists and the data were analyzed descriptively. Further research should include replicated physicochemical and microbiological analyses, larger and systematically selected sensory panels, and appropriate inferential statistical methods.

Author's Contribution

A.N.Ahmadi, S.M. Janah, N.S. Yulisa: Collecting Data, Conducting Analysis and Writing Articles. R.H. Pratiwi: Compiling, Designing Analysis and Reviewing Articles.

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